# Unusual Hidden Symmetries in the $t_{2g}$ Cubic Perovskites and the Magnetic Structure of $LaTiO_3$

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**Abstract**

The transition metal oxides have been the source of many fascinating physical phenomena such as high $T_c$ superconductivity, colossal magnetoresistance, and orbiton physics. These surprising and diverse physical properties arise from strong correlation effects in the $3d$ bands. Most theoretical attempts to understand such systems are based on the Hubbard model. We recently show that[1, 2] for high symmetry transition metal oxides with threefold $t_{2g}$ bands, this model possesses several novel hidden symmetries, which we use to prove that this model does not support long-range spin order at nonzero temperatures – despite the three-dimensional lattice structure. Introduction of spin-orbit coupling does allow spin ordering, but even then the excitation spectrum is gapless due to a subtle continuous symmetry[1, 2]. Thus, the experimentally observed spin order, with a gapped spectrum, of $LaTiO_3$ requires additional deviations from the simple Hubbard model. The main source of such deviations are the significant tilting of the $TiO_6$-octahedra and the small JT distortion which removes the degeneracy of the $t_{2g}$ orbitals. We discuss the effects of these symmetry lowering terms and perform a super-exchange perturbation calculation for the magnetic Hamiltonian, including spin-orbit interaction on the Ti. The resulting magnetic structure is presented. This structure has mainly the G-type antiferromagnetism along the $a$ axis of the orthorhombic structure, with a small ferromagnetic moment along the $c$ axis, and a small A-type antiferromagnetic moment along the $b$ axis.

## References

[1] A. B. Harris, T. Yildirim, A. Aharony, O. Entin-Wohlman, and I. Ya. Korenblit, Phys. Rev. Lett. (in press)(cond-mat/0303219).

[2] A. B. Harris, T. Yildirim, A. Aharony, O. Entin-Wohlman, and I. Ya. Korenblit, Phys. Rev. B. (submitted) (cond-mat/0xxx).